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curve into their abutments are less likely to crack than such as join them at an angle. The majority (213) of the shocks came in the winter.

BOTANY.¹

THE MOVEMENTS OF ROOTS OF INDIAN CORN IN GERMINATION.²—In the recent work of the late Charles Darwin on the movements of plants, he says that roots, stems and leaves bend to all points of the compass successively with a sort of rolling motion which he terms circumnutation—a bowing around

The radicle bends away from any irritant, as a small piece of gum paper attached to one side of the tip. "In whatever direction the primary radicle [or root] first protrudes from the seed, geotropism guides it perpendicularly downwards."

I have carefully studied the movements of some 400 or more kernels of sprouting Indian corn of seven or more varieties, and, so far as they are concerned, Darwin's statement is much too strong in regard to geotropism guiding the radicles perpendicularly downwards. If allowed to germinate on a flat, smooth plate, some of the roots will rise and fall as they move along the surface, making a series of curves, others continue to run flat on the surface, others bend the tip of the root against the plate and curve with so much force that the kernel is tipped over. On a piece of thick, wet paper, the root is often slightly obstructed so that it makes a coil and proceeds forward again.

One of my students repeated some of Darwin's experiments by pinning kernels of germinating corn on a cork, over water in a bottle set in a dark place. Pieces of gum-paper were placed on one side of the tips of the roots. In some cases the root was a trifle, deflected from the paper, in others it was not in the least changed in its course. In some cases single coils were made; in one instance a figure 8 was made and a single coil after that, by which the gum-paper was shoved off, when the root went straight on to the water. It was not sensitive to another paper on the tip. Another root almost tied itself into a knot. Young roots were the most sensitive.

I pinned over 300 kernels of germinating corn to small sticks, which were placed over water in a deep pan, and all closely covered in the dark. Seven varieties of corn were used, some of which were fresh; some of which had been grown some years before. No gum-paper or other objects were placed on any of these roots. It seemed to make little difference which side or which edge or end of the kernel was placed uppermost, the results were equally variable, so far as the direction taken by the roots was concerned. In all of the sorts, one or more coils were very common. One root went off without support in a horizontal direction for three

¹ Edited by PROF. C. E. BESSEY, Ames, Iowa.

² Notes from papers presented at the Cincinnati and the Montreal meetings of the American Association for the Advancement of Science.

inches, some went obliquely upwards; a few went straight up; some making curves, some one, two or even three coils.

For experiments made in 1882 and reported below, I used good, sound yellow-dent corn, one year old, of one variety. I observed nearly 700 germinating kernels in sandy soil, in various situations. The primary and secondary roots, from one to six for each kernel, about 3000 in all, were examined, and not a single instance was found of a coil in the root. The roots in loose sand generally went onward in one direction without abrupt turns, sometimes wavy, sometimes turning by some obstruction.

I placed some clean, damp sand four inches deep in a cellar facing the north, with the temperature about 65° to 75° F., where the surface of the soil remained slightly moist, without supplying water. The surface of the sand was left loose and level.

Three hundred kernels were planted one-half to three-fourths of an inch deep, all with the tips or embryo end down. When most of the plants were showing green leaves above the sand, none over half an inch, I counted 33 roots out of the sand, mostly secondary roots, I suppose. The tips of these were generally curved down, as if sick of the element they were in, and trying to get back into the sand. Mice and squirrels interrupted this experiment. However, after the plumule was two to four inches high, 150 kernels were examined. At this time, some 200 roots were above the ground, three of which were primary roots. The latter had grown three, four and six inches respectively before coming out to the surface. I examined the shape of the tip of 88 of these primary roots for one inch as they were seen below the surface. Twenty-five were straight, 23 were slightly wavy in two planes, the other 40 were more or less curved near the end.

The roots above the sand were somewhat red. Most of them re-entered the soil after coming out on the surface for one to four inches or more. Some never could get back, although the sand was very loose.

Nearly all the roots grew well on the surface and produced and retained trichomes without any trouble. The roots in the sand usually ran downward obliquely, often about 10° to 30° with the surface, very rarely straight down.

A second lot of 150 kernels acted just about like the first, only they were not disturbed by mice or squirrels.

Again, I planted 181 kernels half an inch deep in the cellar, the tip, or end of the kernel grown next the cob, was placed uppermost and patted well as with a hoe. When the ascending axes were about four inches long the plants were examined.

Of these, 89 sent primary roots out of the sand, 92 did not send the primary roots out of the sand. Seventy-five sent the primary root out and in again, one out and in twice, one out and in three times.

Where the primary root came above the sand in these cases, it

generally came out very soon after germination. In one case it grew four inches before coming out. Eight roots were so near the surface, still below it, that they were red for a foot or more. The primary roots in the experiments had reached the length of ten to fourteen inches, and at that length they were always longer than the secondary roots, even if the primaries had run out of the ground. The roots apparently grew about as well out of the sand as in the sand.

In loose, level, sandy soil in the garden, I put in with thumb and finger 118 moistened kernels of corn, with the tips down, about three-fourths of an inch below the surface. The soil was gently patted down. By the side of these, in a similar manner, I planted 92 kernels with the tips uppermost. The weather during this experiment was clear for most of the time, excepting the day previous to examining the corn. Of the 118 kernels planted with the tips down, all sent the plumule up correctly. Sixteen thrust obliquely upward, one secondary root each, very near the surface, where it died; one thrust up two secondaries, which died. No primaries came to the surface.

Of the 92 kernels planted with the tip end up, all sent out of ground a curved plumule. The primary roots usually turned quickly and went obliquely down, on the average about 30 degrees from the perpendicular. They certainly went more directly down than did those tested in the sand in the cellar. Of the 92 kernels with the tips up, nine sent primary roots out of the ground where they died. This is nearly 10 per cent. The growth of the kernel, however, was maintained by the secondary roots. One kernel only of this lot of corn thrust one secondary above the ground, where it died.—*W. J. Beal, Lansing, Mich.*

A SINGULAR HABIT OF *PSORALEA ARGOPHYLLA*.—During an extended trip in Dakota the past summer, this plant was a daily companion. So abundant is it that it gives large areas of the prairie a silvery whiteness. In the latter part of August, a hot south-west wind blew for several days, which so blocked the roads in places with the loose "tops" or stems of this plant as to considerably retard a team in traveling, reminding one of similar experience with the "tumble weed" (*Amarantus albus*), and "tickle-grass" (*Panicum capillare*), near cultivated fields after a frost. The fashion followed by these utterly diverse plants, is beautifully adapted for scattering seed over the prairies. They all form, in growing, a spherical bushy top, but their methods in starting on their journey are very different. In the case of the tickle-grass the panicle breaks off at the first joint below. In the "tumble-weed" the root is usually pulled up to complete the lower part of the sphere, the plant usually growing in a loose soil. But the *Psoralea* growing in a hard turf resorts to the following method: Very near the top of the ground a joint is formed in the stem, as perfect as that for separating a leaf from the stem.

It cuts through all the tissues so that when the top dries up and begins to sway in the wind, it is broken off very readily and evenly. One might perhaps think that the wrenching of the stem was the only cause of the separation, but I satisfied myself that a real joint is formed, by examining plants still green. The bushy top of the *Psoralea* is higher relatively from the ground than that of the *Amarantus*, so that it is roughly spherical without the root.—*J. E. Todd, Beloit, Wis.*

WHENCE CAME THE WILD POTATOES OF ARIZONA.—Several years ago August Fendler collected near El Paso, New Mexico, a kind of potato used largely by the Navajo Indians, and which resembled the cultivated potato, except in size; the tubers are not larger than filberts. Dr. Gray named the species for the discoverer—*Solanum Fendleri*. The tubers have been heard of but once since, and that was in 1879, when Dr. Palmer collected a handful that, being sent to the Agricultural Department at Washington, found their way at last into the hands of Prof. Meehan, who planted them, and cultivated them for a few years, when, for no apparent reason, they were lost.

During the summer just past (1882), we discovered a new locality for this species in the Huachuca, New Mexico; also of another species, formerly known from the mountains of Colorado—*S. Jamesii* Torr. The latter, we believe, has never been tested in cultivation, yet it is very promising, for its short stolons and readily improved size of tuber. Both species we found invading the few gardens of the region, seemingly rejoicing in being able to escape the attacks of the gardener by reason of their close resemblance to the genuine *S. tuberosum*. Though found also on the high slopes in the shade, yet they were larger in the gardens. Humboldt shows us that the potato was not known in Mexico at the time of the Incas, while it is now found in various parts of the republic, in a wild, neglected condition.

Now whence came it? Did an immigration subsequent to that of the Aztecs bring this esculent and plant it along the Rio Grande and the Gila? Or is it truly indigenous? Dr. Gray concludes (in his latest works) that the so-called distinct species of *Solanum Fendleri* is only a form of the original *S. tuberosum*, and he arranges it as "*var. boreale* Gray." Also he says of the other plant—*S. Jamesii*—that although "it appears on the whole to be distinct," yet "there are good reasons for suspecting that these two forms, with several others in Mexico, are but varieties of the Peruvian *S. tuberosum*." If so, why is not their cultivation possible? and why is their source lost? Humboldt argued, in 1812, that if Sir Walter Raleigh's colonists *did* bring the potato from Virginia, it must have been derived from a plant indigenous to the northern hemisphere, and thus he pointed out this discovery nearly a half century afterward. But Dr. Gray argues that the potato

of Virginia must have recently been imported there by Spaniards, for it was not a small, half-sized potato that grew in Sir Walter's garden, but evidently large, attractive tubers, already brought up to size by long cultivation.

Was the potato carried across from the Rio Grande to the foot of the Alleghenies in an early day? and if so, by whom?—*Fr. G. Lemmon, Oakland, Cal., Jan. 23, 1883.*

P. S.—Tubers of these native potatoes were collected, and, when the spring opens, will be sent out in securely packed parcels of a dozen each, to applicants, addressing J. G. Lemmon, Lemmon Herbarium, Oakland, Cal.

THE NUMBER OF SPECIES OF NORTH AMERICAN FLOWERING PLANTS.—In a paper read last year to the botanists at the Montreal meeting of the American Association for the Advancement of Science, Dr. Gray gave some interesting facts as to the number of species of flowering plants in North America, north of Mexico. According to it, in 1878, the Polypetalæ numbered 3038, and the Gamopetalæ after Compositæ 1656 species. Adding the increase of four years, Dr. Gray estimates that these two alone must reach "about 5000 species." He further estimates that these "must make up half our phænogamous botany," so that upon this basis we should have for the whole at least 10,000 species. The great increase in the number of Compositæ, will probably carry the number somewhat higher than this; and when we add the introduced species (which already reach no small number) "the 10,000 species of this estimate may before long rise to eleven or twelve thousand."

NOTE ON THE VITALITY OF *SENECIO SCANDENS*.—A thrifty vine of German Ivy was trained upon the sides and top of a large room. The stems were perhaps over fifteen feet in length. On the first day of last June it was removed, with the exception of two pieces five or six feet long, which were left hanging upon strings at the top of the room. These seemed unconscious that they were cut off from their base of supplies, and continued green, and one grew several inches. The terminal end of this was taken down November 1st, and is now growing vigorously in a pot of earth. The other branch left undisturbed remained green, a portion of it, till about New Years. The room was used as a study, and was occupied most of the time.—*J. E. Todd, Beloit, Wis. Feb. 5, 1883.*

BOTANICAL NOTES.—The article "Botany" by J. C. Arthur, in the History of Floyd county, Iowa, is a model of what such an article should be. It includes brief general notices of the lower as well as the higher plants. A page is given to the sexless plants (Protophyta); another page to the unisexual plants (Zygosporeæ); half a page to the egg-spore plants (Oösporeæ); two pages to the mushrooms and their allies (Carposporeæ); a para-

graph to the mosses and liverworts (Bryophyta), and another to the ferns and their allies (Pteridophyta); with four pages to the seed-bearing plants (Phanerogamia).—Forestry Bulletin, No. 18, gives the fuel values of fifty-five of the more important woods of the United States. The first five on the list are (1) *Cercocarpus ledifolius*, (2) *Pinus australis*, (3) *Carya alba*, (4) *Quercus prinus*, (5) *Pinus rigida*.—Forestry Bulletins, 19, 20 and 21, contain maps showing the forest areas of California, Oregon and Washington Territory. Of the latter the remark is made that "west of the Cascade mountains it is covered by the heaviest continuous belt of forest growth in the United States." Of this the "red or yellow fir" (*Pseudotsuga douglasii*) known in the East as the Douglas spruce, forms "about seven-eighths of the forest growth."—Henry Trimen in the Dec. number of the *Journal of Botany* announces his withdrawal from that periodical, declining "to risk any further loss." James Britten, the well-known editor, has bravely "determined to carry on the journal" at his own risk "for at least another year," and appeals to its friends for aid in obtaining additional subscribers. Cannot American botanists do somewhat towards aiding Mr. Britten in his laudable attempt to keep alive this old and valuable journal. Subscriptions (twelve shillings) should be sent to the publishers, West, Newman & Co., 54 Hatton Garden, London, E. C., England.—In contrast with the foregoing, it is gratifying to note the steady growth of the *Botanical Gazette*, now entered upon its eighth year, enlarged and greatly improved. It is upon a good footing, financially, and Professor Coulter is to be congratulated upon the assured success of his undertaking. The addition of Professor C. R. Barnes and Mr. J. C. Arthur to the editorial force will doubtless enable the *Gazette* to make still further improvement.—Davis L. James has republished in the Jour. Cinn. Soc. Nat. Hist., the descriptions of new species of Fungi collected in the vicinity of Cincinnati, by Thomas G. Lea, and described by Rev. M. J. Berkeley. The original, published in 1849, has long been so rare as to be practically inaccessible to all but a very few students. Descriptions are given of fifty-three species; of these twenty-three are noted as having been described also in *Hooker's Jour. Bot.*, Vol. iv.—Dr. Goodale, of Harvard University, has recently imported from Germany a large quantity of apparatus for making experiments and investigations in vegetable physiology. A new laboratory for physiological work is to be erected just back of the present row of buildings at the Botanic Gardens.

ENTOMOLOGY.¹

THE FOOD RELATIONS OF THE CARABIDÆ AND COCCINELLIDÆ.—Professor S. A. Forbes, State entomologist of Illinois, has just published a valuable paper entitled, "The food relations of the

¹ This department is edited by Professor C. V. RILEY, Washington, D. C., to whom communications, books for notice, etc., should be sent.